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THE FORCES AND MOMENTS ON A MISSILE DUE TO A FLUID JET EJECTING LATERALLY

Vol. II - Computer Program and Operating Instructions (SIDJET)

by

G. D. Kuhn

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NIELSEN ENGINEERING
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NAVAL SEA SYSTEMS COMMAND
Dept. of the Navy
Washington, D.C. 20362

by

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A computer program and user's instructions are presented for calculating lateral jet induced forces and moments on finless missiles, missiles with monoplane wings and on missiles with cruciform fin configurations. For bodies with no fins, simple formulas are used for the jet induced forces and moments. For cruciform finned bodies, a tabular data base is used. For bodies with monoplane wings, a combination of the body-alone formulas and the cruciform data is used.

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THE FORCES AND MOMENTS ON A MISSILE DUE TO A FLUID JET EJECTING LATERALLY

Volume II. Computer Program and Operating Instructions (SIDJET)

1. INTRODUCTION

Under Contract No. N00024-79-C-5381 with Naval Sea Systems Command, Nielsen Engineering & Research, Inc. (NEAR) has developed engineering aerodynamic prediction methods for calculating lateral jet induced forces and moments on finless missiles, missiles with monoplane wings and on missiles with cruciform fin configurations. Those methods concern the problem of accounting for the forces and moments induced by interference between jets issuing from the side of a missile and the external flow around the missile. For bodies with no fins, the method of least squares was used to correlate the available data to obtain simple formulas for the jet induced force and moment. For cruciform finned bodies, an extensive set of data from wind tunnel tests was used to develop a tabular data base from which the forces and moments can be calculated. For bodies with monoplane wings, a combination of the body-alone formulas and the cruciform data is used.

This report presents instructions for using the computer program developed to implement the prediction methods. The program is constructed as a primary subroutine (SUBROUTINE SIDJET) and several auxiliary subroutines. The calling program can be simply a program for reading the required input data and printing the output quantities or a more sophisticated program of any kind.

The remainder of this report describes the equations and procedures programmed, the input requirements of the program, and the output quantities that are calculated by the program. Sample cases are presented to aid in checking out the program.

2. EQUATIONS AND PROCEDURES PROGRAMMED

2.1 Forces and Moments on a Body of Revolution With a Radial Jet

The general problem is of jets issuing from a missile body and interfering with the body pressure distribution. During the outward movement of the jet, it turns downstream as a result of interacting with the free stream. During its downstream passage the jet entrains free-stream air.

If the jet exhausts into a vacuum, the reaction force on the missile is dependent only on the jet momentum. However, because there is airflow around the missile, interference between the jet and the external airflow can cause an additional external reaction which can either amplify or reduce the net force on the missile and create an additional moment due to the displacement from the jet centerline of the center of pressure of the flow field.

The amplification of the jet reaction force is defined as

$$K_N = \frac{F_T + F_i}{F_T} \tag{1}$$

where

F_T = the jet thrust without external flow

F_i = the additional reaction due to the jet/external flow interaction

The moment produced by the jet/external flow interaction is defined in terms of

$$K_{M_j} = \frac{F_i(x_j - x_i)}{F_T D} \tag{2}$$

where

x_j = the jet axial station measured positive aft

x_i = the axial location of the center of pressure of the interaction force

D = the body (reference or maximum) diameter

The expressions used to calculate K_N and K_{M_j} (derived from least squares fits of experimental data) are

$$K_N = 0.6118 + 0.1358(1 - 0.485\sqrt{\ell/D})/\sqrt{C_T} + 0.0946M_\infty + 0.004317/(\ell/D) \tag{3}$$

and

$$K_{M_j} = 0.5582 - 0.1884/\sqrt{C_T} - 1.9659/(\ell/D) \tag{4}$$

where

ℓ = axial distance of jet from base of missile

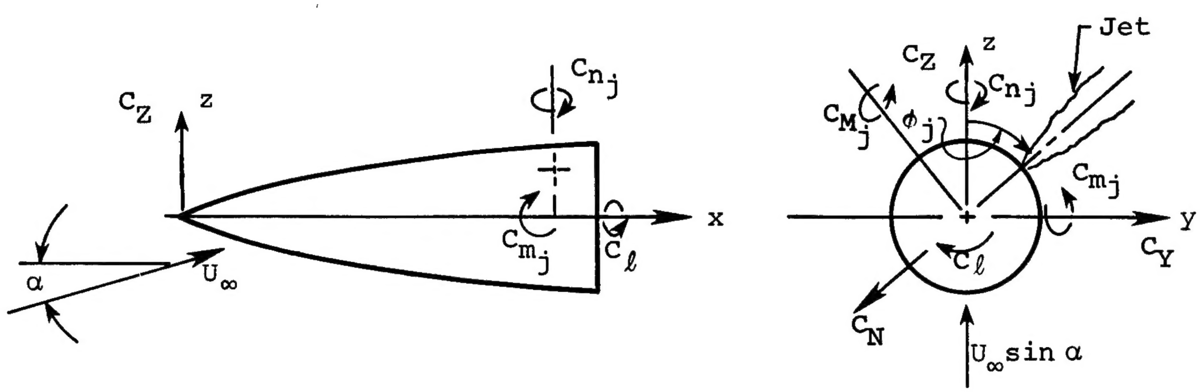
C_T = jet thrust coefficient, $F_T/q_\infty S$

M_∞ = free stream Mach number

q_∞ = free stream dynamic pressure

S = reference (maximum) cross sectional area of body

The forces and moments corresponding to equations (3) and (4) for a particular configuration are calculated using the right handed coordinate system shown in the sketch.



The normal force and moment coefficients in the plane of the jet are:

$$C_N = -C_T K_N \tag{5}$$

$$C_{M_j} = C_T K_{M_j} \tag{6}$$

and the components of the force and moment in the coordinates shown are:

$$C_Z = C_N \cos\phi_j \tag{7}$$

$$C_Y = C_N \sin\phi_j \tag{8}$$

$$C_{m_j} = C_{M_j} \cos\phi_j \tag{9}$$

$$C_{n_j} = C_{M_j} \sin\phi_j \tag{10}$$

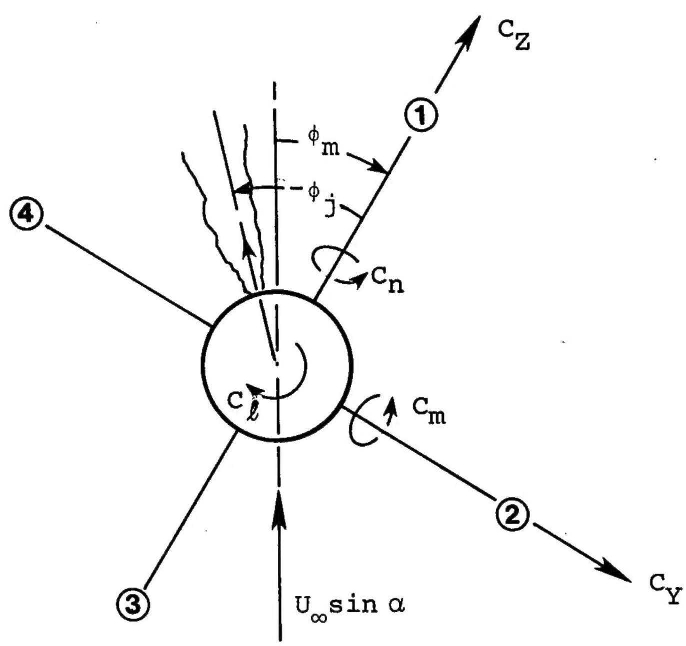
$$C_\ell = 0 \tag{11}$$

2.2 Forces and Moments on a Cruciform Wing-Body Combination with a Radial Jet

Addition of wings and fins to the bodies of revolution discussed previously introduces major new complications in estimating the forces

and moments resulting from the jet issuing from the body. Most obvious, the fins permit development of rolling moments when acted on by the pressure field and trailing vortices of the jet. The fins also allow major increments in the normal and side forces and their accompanying transverse moments.

The extreme complexity of the jet-body-fin interaction problem precluded the development of simple formulas for the forces and moments. Consequently, recourse was made to a data base in which the five force and moment coefficients, C_Z, C_Y, C_{m_j}, C_{n_j} and C_ℓ are tabulated as functions of the missile angle of attack, α, and roll angle ϕ_m (see sketch), the jet axial position, x_j and the jet azimuthal position, ϕ_j.



The roll angle, ϕ_m, is the angle between the plane of the wing (number 1 in the sketch) which is adjacent to and clockwise from the jet (when viewed from the rear) and the plane containing the missile axis and the flight velocity vector. The angle ϕ_m is positive clockwise. The jet azimuthal angle, ϕ_j, is the angle between the jet axis and wing number 1. The angle ϕ_j varies from 0° when the jet blows along wing number 1 to -90° when the jet blows along wing number 4. The angle of attack varies

from -10° to $+10^{\circ}$ in the data base. The jet axial position is tabulated in terms of the position relative to the fin (wing) root leading edge, $(x_j - x_{LE})/L_F$, where L_F is the fin (wing) root chord and x_{LE} is the axial coordinate of the fin (wing) root leading edge. The force and moment coefficients are normalized by the jet thrust coefficient. A proportional relationship between the interaction forces and moments and the jet thrust is used, based on experimental measurements at three different thrust levels. The free stream Mach number of the experimental tests was 1.6 for most of the data. A few tests at Mach numbers of 1.8 and 2.1 indicated that a reasonable first approximation is that Mach number effects over this range are negligible. Therefore, variations with Mach number are not included in the tabulated data base. It is felt that the data base can be used in the low supersonic Mach range with reasonable results, but it has not been validated for subsonic speeds because of the lack of data. Likewise, variations with fin (wing) span are not included because such effects were not separable from the effect of the chordwise position of the jet for the swept-leading-edge fin used in the wind tunnel tests. The values of the independent variables used in the tabulated data are as follows:

α : $0°, \pm 2°, \pm 4°, \pm 10°$

$\dfrac{x_j - x_{LE}}{L_F}$: 0.19, 0.54, 0.89

ϕ_j : $-22.5°, -45°, -67.5°$

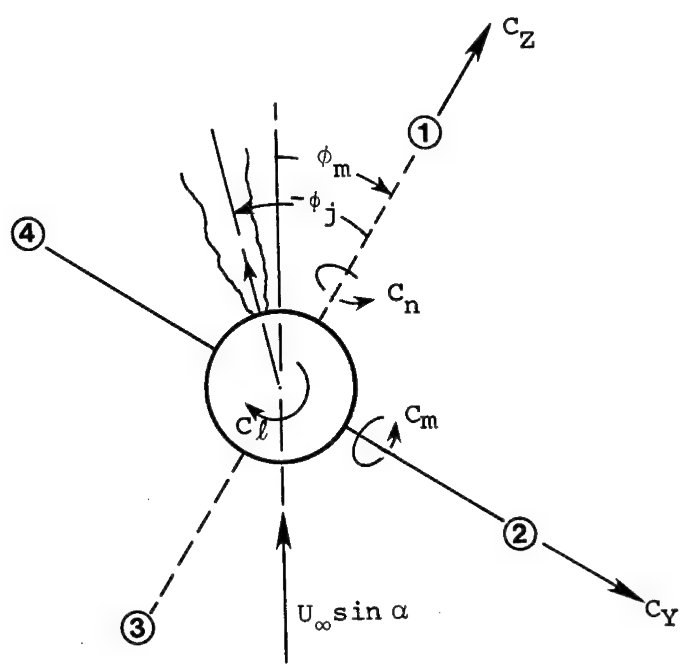
ϕ_m : $0, 22.5°, 45°, 67.5°, 90°, 135°, 180°, 202.5°$
$225°, 247.5°, 270°, 315°, 360°$

The tabulated data are interpolated in the following manner: First, the input values of α, ϕ_m, ϕ_j and x_j are compared with the values corresponding to the tabulated data to obtain bracketing values for each quantity. Those sixteen quantities are reduced to eight by interpolating to the input value of α. The eight interpolated values are reduced to four by interpolating in ϕ_m. The four new values are reduced to two by interpolating in ϕ_j, and the final interpolation in x_j produces the result. For values of the input parameters outside the range of the tables, the

results should be used with caution. Experimental measurements were available for angles of attack up to approximately $\pm$ 12°, but the variation of the interaction forces and moments for higher angles of attack is not known. Likewise, experimental data were obtained for values of ϕ_j of -67.5° and -45°, with the tabulated data at ϕ_j = -22.5° obtained by symmetry relations. The effect of a jet nearer a fin than 22.5° is not expected to be drastically different than at 22.5°. In order to provide the most reasonable results for analyzing the trajectory of a vehicle, the boundary values of the tabulated data are used for input parameters outside the range of the tables rather than an extrapolation, because calculations showed extrapolated values to be quite unreasonable in some cases.

2.3 Forces and Moments on a Monoplane Wing-Body Combination With a Radial Jet

The calculative procedure for a monoplane winged configuration uses a combination of the procedures for cruciform configurations and body-alone configurations. To illustrate the procedure, the sketch below shows a missile viewed from the rear at a small roll angle. This is essentially the same configuration as was shown for cruciform configurations except that fins 1 and 3 are assumed to be missing.



The induced normal force and pitching moment, C_Z and C_{m_j} on the cruciform configuration, are produced primarily by the jet thrust and the induced force on the body and fin number 4. For the monoplane case, it is assumed that the removal of fin number 1 has a negligible effect on the manner in which the jet affects the flow over fin number 4. Likewise, the removal of fin 3 has a negligible effect on the manner in which the jet influences fin number 2, particularly since the two fins are on the side away from the jet. Thus, the C_Z and C_{m_j} for a monoplane configuration are determined directly from the cruciform data base.

In the absence of the vertical wing the induced side forces can only be produced by the jet and its interaction with the body. It is assumed that the influence of the horizontal wing on the jet is negligible. Therefore, the incremental side force and moment are taken to be those for the case of a jet from a body without wings. Thus,

$$C_Y = C_Y \text{ for a body without wings}$$

$$C_n = C_n \text{ for a body without wings}$$

The recommended relationship for the induced rolling moment is

$$C_\ell = +0.6\ C_N \sin \phi_j$$

in which the term $\sin \phi_j$ has been inserted in order to obtain zero roll moment for a jet flowing in the plane of symmetry.

2.4 Forces and Moments on a Body with Both Wings and Tails

No provision is made in the program for calculation of forces and moments on a body with both wings and tails. Such calculations can be made, however, by simply providing the required information for the set of surfaces that are most likely to interact with the jet. For example, if the jet is located ahead of the wing trailing edge, the wings themselves would probably be the most likely surfaces to be defined in the input to the program. On the other hand, if the jet is located aft of the wing trailing edge but ahead of the tail trailing

edge, the tail surfaces should be input. Some judgment must be exercised by the user in determining the appropriate input quantities depending on the relative sizes of the wing and tail surfaces and their proximity to each other as well as to the jet.

3. PROGRAM OPERATING INSTRUCTIONS

3.1 Input Data Required

Communication with subroutine SIDJET is through a formal parameter list. Programming of specific input/output procedures is left for the user to provide. The input quantities required by the program are as follows:

Variable Name	Description
NCONFG	An index for identifying the type of configuration under consideration 0 - body alone 2 - monoplane 4 - cruciform Any other value input will cause the printing of the message "configuration index in error"
XJIN	Distance of jet from nose
PHIJIN	Azimuthal location of jet, ϕ_j, degrees
PHIMIN	Roll angle of missile, ϕ_m, degrees
ALPHIN	Angle of attack, α, degrees
L	Total length of missile
D	Maximum or reference diameter of missile

CT — Jet thrust coefficient, C_T = jet thrust with no external flow/$(q_\infty \pi D^2/4)$. This can be approximated by

$$C_T = \frac{p_{t_j}}{q_\infty}\left[2\left(\frac{2}{\gamma_j+1}\right)^{\frac{1}{\gamma_j-1}} - \frac{p_a}{p_{t_j}}\right]\left(\frac{d_j}{D}\right)^2$$

where p_a = ambient static pressure

p_t = jet stagnation pressure

γ_j = jet ratio of specific heats

MINF — Flight Mach number, M_∞ (.6-4.0)

XLE — Distance from nose to fin root leading edge

LF — Length of fin root chord

OPFLAG — Initialization index; should be set to zero in the main program before the first call to subroutine SIDJET. In normal operation, OPFLAG is then set to 999 in subroutine TABULA after initialization of certain arrays. Subsequent calls to SIDJET with OPFLAG unchanged cause the initialization to be passed over.

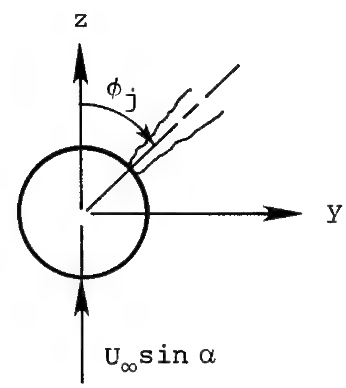
3.2 Special Instructions for Preparing Input Data

3.2.1 Units.- All quantities with length dimensions can be input in any units including nondimensional. The main rule is that all units must be consistent. If one of the input lengths is chosen as a reference quantity to nondimensionalize the other lengths, the reference quantity should be input as 1.0. All lengths are subsequently nondimensionalized in SIDJET using either the body diameter or the fin length independent of any previous nondimensionalization of the input data. All angles are input in degrees.

3.2.2 Angles.- The two angles, PHIJIN and PHIMIN require special consideration of the type of configuration being treated. Different coordinate systems are used, depending on the configurations. The finless case (body alone) uses the crossflow wind as reference. The monoplane uses the "top", since such configurations are bank-to-turn, aircraft-like vehicles. The cruciform configuration has no preferred bank angle, so the fin adjacent to the jet is used as a reference.

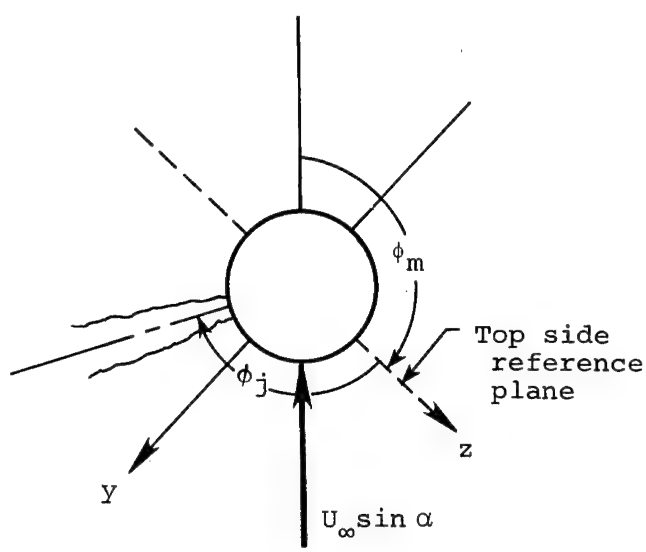
Finless Configuration

Measure ϕ_j clockwise from a leeward reference plane (looking forward from the tail of the missile). The allowable range of ϕ_j is $0 \leq \phi_j \leq 360^o$. The roll angle, ϕ_m is not used for this configuration. The forces and moments are resolved into components in the right-handed system shown.



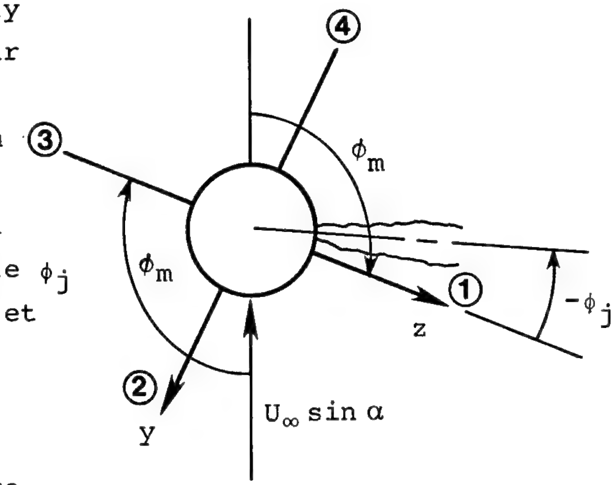
Monoplane Configuration

Designate the top side symmetry plane of the vehicle as reference. Measure ϕ_j clockwise from that plane to the jet axis. Measure ϕ_m clockwise from the leeward (for positive angle of attack) plane containing the wind vector and the body axis to the reference plane. Both ϕ_j and ϕ_m can be between 0^o and 360^o. The forces and moments are then resolved into the y-z coordinate system shown



Cruciform Configuration

The cruciform fin data tables apply to a jet located between two particular fins. Thus, for a given jet position, the fin nearest the jet clockwise from the jet should be designated as fin number 1. The other fins are numbered clockwise from fin number 1. The angle ϕ_j is measured from fin number 1 to the jet ($-90^\circ \leq \phi_j \leq 0^\circ$). The angle ϕ_m is measured from the wind vector to fin number 3 as shown (for positive angle of attack). The forces and moments are determined in the y-z coordinate system shown, that is, in general z is positive along fin number 1 and y is positive along fin number 2. All moments are referred to the jet location.



3.3 Output

The output from program SIDJET consists of the force and moment coefficients as follows:

CZ	component of normal force in the z direction (see sketches in previous section for definition of coordinate axes for the various allowable configurations)
CY	component of normal force in the y direction
CMJ	component of moment about the y axis at the jet axial position - positive nose up
CNJ	component of moment about the z axis at the jet axial position - positive nose right
CL	rolling moment about the missile axis - positive right wing down or clockwise looking forward

4. SAMPLE CASES

4.1 Wingless Body

Input quantities required for a sample calculation on a wingless body are as follows:

NCONFG = 0
XJIN = 4.364
PHIJIN = 20°
PHIMIN = 0°
ALPHIN = 0°
L = 9.0
D = 1.0
CT = .4068
MINF = 1.5
XLE = 0.0
LF = 0.0
OPFLAG = 0

The output quantities will then be

C_Z = -.2849
C_Y = -.1037
CMJ = -.0616
CNJ = -.0224
CL = 0

4.2 Cruciform Wing-Body Configuration

Input quantities for a sample calculation on a cruciform wing-body combination are as follows:

NCONFG = 4
XJIN = 20.0
PHIJIN = -40.0
PHIMIN = 30.0

ALPHIN = -4.0
L = 35.63
D = 2.52
CT = 1.0
MINF = 1.6
XLE = 15.54
LF = 17.41
OPFLAG = 0

The output quantities will be

CZ = -.0621
CY = -.0282
CMJ = -2.5317
CNJ = 1.9349
CL = .0092

4.3 Monoplane Wing-Body Configuration

Input quantities for a sample calculation on a monoplane wing-body combination are as follows:

NCONFG = 2
XJIN = 20.0
PHIJIN = 320.0
PHIMIN = 30.0
ALPHIN = -4.0
L = 35.63
D = 2.52
CT = 1.0
MINF = 1.6
XLE = 15.54
LF = 17.41
OPFLAG = 0

The output quantities will be

$$CZ = -.0621$$
$$CY = .4748$$
$$CMJ = -2.5317$$
$$CNJ = .0271$$
$$CL = .0240$$

5. COMPUTER PROGRAM LISTING

```
      SUBROUTINE SIDJET (NCONFG,XJIN,PHIJIN,PHIMIN,ALPHIN,L,D,
     *                   CT,MINF,XLE,LF,OPFLAG,CN,CY,CMJ,CNJ,CL)
      REAL L,LD,MINF,LF
      INTEGER OPFLAG
C                                                                   C
C   THIS SUBROUTINE IS DESIGNED TO CALCULATE NORMAL Y AND Z FORCES    C
C   AND PITCHING, ROLLING AND YAWING MOMENTS OF A MISSILE GIVEN:      C
C                                                                   C
C          INPUT VALUE            VARIABLE NAME        RANGE         C
C          -----------            -------------        -----         C
C          CONFIGURATION          NCONFG               0,2,4         C
C          JET LOCATION           XJIN                               C
C          JET AZIMUTHAL POS.     PHIJIN              -90.0 TO 0.0   C
C          MISSILE ROLL ANGLE     PHIMIN               0 TO 360      C
C          ANGLE OF ATTACK        ALPHIN              -10 TO 10      C
C          THRUST COEFFICIENT     CT                                 C
C          MISSILE LENGTH         L                                  C
C          MISSILE DIAM.(REF.)    D                                  C
C          AXIAL LOCATION OF      XLE                                C
C             WING ROOT LEADING                                      C
C             EDGE                                                   C
C          WING ROOT CHORD        LF                                 C
C          MACH NUMBER            MINF                               C
C          TABLE INITIALIZATION   OPFLAG                             C
C             FLAG SHOULD BE                                        C
C             SET TO ZERO IN MAIN                                    C
C             AT START OF PROGRAM                                    C
C                                                                   C
C                                                                   C
C                                                                   C
C   THIS IS DONE EITHER THROUGH CALCULATION OF THESE FORCES AND MOMENTS
C   OR THROUGH INTERPOLATION OF TABLES OF EXPERIMENTAL AND CALCULATED
C   DATA, DEPENDING ON THE CONFIGURATION OF THE BODY IN QUESTION, I.E.,
C   WINGLESS, MONOPLANE, OR CRUCIFORM                                 C
```

```
C                                                                   C
C  THIS SUBROUTINE RETURNS THE FOLLOWING VALUES:                    C
C                                                                   C
C         OUTPUT VALUE                 OUTPUT NAME                  C
C         ------------                 -----------                  C
C         NORMAL FORCE COEFFICIENT     CN                           C
C         SIDE FORCE COEFFICIENT       CY                           C
C         PITCHING MOMENT ABOUT        CMJ                          C
C            JET AXIAL POSITION                                     C
C         YAWING MOMENT ABOUT          CNJ                          C
C            JET AXIAL POSITION                                     C
C         ROLLING MOMENT               CL                           C
C                                                                   C
C                                                                   C
      COMMON /MASTBL/ DCNX1(13,3,7),DCNX2(13,3,7),DCNX3(13,3,7),
     *                DCYX1(13,3,7),DCYX2(13,3,7),DCYX3(13,3,7),
     *                DCMX1(13,3,7),DCMX2(13,3,7),DCMX3(13,3,7),
     *                DCHX1(13,3,7),DCHX2(13,3,7),DCHX3(13,3,7),
     *                DCLX1(13,3,7),DCLX2(13,3,7),DCLX3(13,3,7)
      IBOUND=0
      JUMPMP=0
C                                                                   C
C  DECIDE ON THE BASIS OF CONFIGURATION NUMBERS WHETHER THE         C
C  MISSILE IS OF THE BODY-ALONE, CRUCIFORM OR MONOPLANE TYPE        C
C                                                                   C
C  IF BODY ALONE CONFIGURATION, USE CALCULATED VALUES OF FORCE      C
C  AND MOMENT                                                       C
C                                                                   C
      IF (NCONFG.EQ.0) GO TO 100
C                                                                   C
   IF WINGED, BUT JET TRAILS ALL WINGS AND/OR TAILS, USE BODY-ALONE DATA
C                                                                   C
      IF (NCONFG.EQ.2.AND.XJIN.GT.XLE+LF) GO TO 100
      IF (NCONFG.EQ.4.AND.XJIN.GT.XLE+LF) GO TO 100
C                                                                   C
C  IF CRUCIFORM CONFIGURATION, VALUES OF FORCE AND MOMENT ARE       C
C  INTERPOLATED FROM TABLES OF EXPERIMENTAL AND CALCULATED DATA     C
C                                                                   C
      IF (NCONFG.EQ.4.AND.XJIN.LE.XLE+LF) GO TO 200
C                                                                   C
C  IF MISSILE IS MONOPLANE, AND JET IS NOT AFT OF WING SURFACES,    C
C  A COMBINATION OF BODY-ALONE AND CRUCIFORM CALCULATIONS IS DONE   C
C                                                                   C
      IF (NCONFG.EQ.2.AND.XJIN.LE.XLE+LF) GO TO 300
C                                                                   C
C  IF THE CONFIGURATION IS NONE OF THESE, EXIT THE SUBROUTINE       C
C                                                                   C
      GO TO 400
C                                                                   C
C  CALCULATE NORMAL FORCES AND MOMENTS FOR BODY ALONE CONFIGURATION C
C                                                                   C
```

```
  100 LD=(L-XJIN)/D
      IF (LD.GT.6.0) LD = 6.0
      IF (CT.LT.0.0.OR.LD.LE.0.0) GO TO 120
      CNT=0.611845+(0.135753/SQRT(CT))*(1.0-(0.484984*SQRT(LD)))
     *    +(0.094633*MINF)+(0.004317/LD)
      CNT=-CNT
      CMJ1=.558196-(.188399/SQRT(CT))-(1.96586/LD)
      GO TO 121
  120 CNT = 0.0
      CMJ1 = 0.0
  121 PHIRAD=PHIJIN*.0174533
      IF (JUMPMP.NE.0) GO TO 125
      CN=CNT*COS(PHIRAD)*CT
      CY=CNT*SIN(PHIRAD)*CT
  125 IF (CT.EQ.0.0) GO TO 130
      XI = XJIN-D*(CMJ1/( 1-ABS(CNT)     ))
      IF (XI.GT.L) CMJ1 =-    ( ABS(CNT)     -1)*((XJIN-L)/(2*D))
      CMJ1=CT*CMJ1
      IF (JUMPMP.NE.0) GO TO 355
      CMJ = CMJ1 * COS(PHIRAD)
      GO TO 132
  130 CMJ=0.0
  132 CNJ=CMJ1*SIN(PHIRAD)
      CL=0.0
      GO TO 900
C                                                                      C
C  INITIALIZE TABLE OF EXPERIMENTAL AND CALCULATED DATA FOR USE        C
C  IN INTERPOLATION OF FORCE AND MOMENT VALUES OF CRUCIFORM            C
C  CONFIGURATION                                                       C
C                                                                      C
  200 IF (OPFLAG.NE.999) CALL TABULA (OPFLAG)
      XJO = (XJIN-XLE)/LF
      IF (XJO.GT.0.19.AND.XJO.LT.0.89) GO TO 230
      IF (XJO.GE.0.89) GO TO 220
C                                                                      C
C  IF INPUT VALUE OF XJ IS LESS THAN THE MINIMUM TABLE VALUE,          C
C  CALCULATE FORCE AND MOMENT USING THE LOWER BOUND TABLE ONLY         C
C                                                                      C
      XLO=.19
      XHI=.19
      IBOUND = 1
      CALL INT(PHIJIN,PHIMIN,ALPHIN,DCMX1,DCMX1,XLO,XHI,IBOUND,XJO,CMJ)
      CALL INT(PHIJIN,PHIMIN,ALPHIN,DCNX1,DCNX1,XLO,XHI,IBOUND,XJO,CN)
      CMJ=CMJ*CT
      CN=CN*CT
      IF(JUMPMP.NE.0)GOTO 350
      CALL INT(PHIJIN,PHIMIN,ALPHIN,DCYX1,DCYX1,XLO,XHI,IBOUND,XJO,CY)
      CALL INT(PHIJIN,PHIMIN,ALPHIN,DCHX1,DCHX1,XLO,XHI,IBOUND,XJO,CNJ)
      CY=CY*CT
      CNJ=CNJ*CT
      CALL INT(PHIJIN,PHIMIN,ALPHIN,DCLX1,DCLX1,XLO,XHI,IBOUND,XJO,CL)
      CL=CL*CT
      GO TO 900
C                                                                      C
C  IF INPUT VALUE OF XJ IS GREATER THAN THE MAXIMUM TABLE VALUE,       C
C  CALCULATE FORCE AND MOMENT USING THE UPPER BOUND TABLE ONLY         C
C                                                                      C
```

```
  220 XLO=.89
      XHI=.89
      IBOUND = 1
      CALL INT(PHIJIN,PHIMIN,ALPHIN,DCMX3,DCMX3,XLO,XHI,IBOUND,XJO,CMJ)
      CALL INT(PHIJIN,PHIMIN,ALPHIN,DCNX3,DCNX3,XLO,XHI,IBOUND,XJO,CN)
      CMJ=CMJ*CT
      CN=CN*CT
      IF(JUMPMP.NE.0)GOTO 350
      CALL INT(PHIJIN,PHIMIN,ALPHIN,DCYX3,DCYX3,XLO,XHI,IBOUND,XJO,CY)
      CALL INT(PHIJIN,PHIMIN,ALPHIN,DCHX3,DCHX3,XLO,XHI,IBOUND,XJO,CNJ)
      CY=CY*CT
      CNJ=CNJ*CT
      CALL INT(PHIJIN,PHIMIN,ALPHIN,DCLX3,DCLX3,XLO,XHI,IBOUND,XJO,CL)
      CL=CL*CT
      GO TO 900
C                                                                      C
C  IF INPUT XJ IS WITHIN BOUNDS, AND BETWEEN MIDDLE AND UPPER          C
C  VALUES, INTERPOLATE USING MIDDLE AND UPPER TABLES                   C
C                                                                      C
  230 XLO = .54
      XHI = .89
      IF (XJO.GT.0.19.AND.XJO.LE.0.54) GO TO 240
      CALL INT(PHIJIN,PHIMIN,ALPHIN,DCMX2,DCMX3,XLO,XHI,IBOUND,XJO,CMJ)
      CALL INT(PHIJIN,PHIMIN,ALPHIN,DCNX2,DCNX3,XLO,XHI,IBOUND,XJO,CN)
      CMJ=CMJ*CT
      CN=CN*CT
      IF(JUMPMP.NE.0)GOTO 350
      CALL INT(PHIJIN,PHIMIN,ALPHIN,DCYX2,DCYX3,XLO,XHI,IBOUND,XJO,CY)
      CALL INT(PHIJIN,PHIMIN,ALPHIN,DCHX2,DCHX3,XLO,XHI,IBOUND,XJO,CNJ)
      CY=CY*CT
      CNJ=CNJ*CT
      CALL INT(PHIJIN,PHIMIN,ALPHIN,DCLX2,DCLX3,XLO,XHI,IBOUND,XJO,CL)
      CL=CL*CT
      GO TO 900
C                                                                      C
C  IF INPUT XJ IS WITHIN BOUNDS, AND BETWEEN LOWER AND MIDDLE          C
C  VALUES, INTERPOLATE USING LOWER AND MIDDLE TABLES                   C
C                                                                      C
  240 XLO = .19
      XHI = .54
      CALL INT(PHIJIN,PHIMIN,ALPHIN,DCMX1,DCMX2,XLO,XHI,IBOUND,XJO,CMJ)
      CALL INT(PHIJIN,PHIMIN,ALPHIN,DCNX1,DCNX2,XLO,XHI,IBOUND,XJO,CN)
      CMJ=CMJ*CT
      CN=CN*CT
      IF(JUMPMP.NE.0)GOTO 350
      CALL INT(PHIJIN,PHIMIN,ALPHIN,DCYX1,DCYX2,XLO,XHI,IBOUND,XJO,CY)
      CALL INT(PHIJIN,PHIMIN,ALPHIN,DCHX1,DCHX2,XLO,XHI,IBOUND,XJO,CNJ)
      CY=CY*CT
      CNJ=CNJ*CT
      CALL INT(PHIJIN,PHIMIN,ALPHIN,DCLX1,DCLX2,XLO,XHI,IBOUND,XJO,CL)
      CL=CL*CT
      GO TO 900
C                                                                      C
C  FOR MONOPLANE CONFIGURATIONS, CHOOSE THE QUADRANT IN WHICH          C
C  INPUT QUANTITY PHI JET APPEARS                                      C
C                                                                      C
```

```
  300 IF (PHIJIN.GE.0.0.AND.PHIJIN.LE.90.0) GO TO 330
      IF (PHIJIN.GT.90.0.AND.PHIJIN.LE.180.0) GO TO 320
      IF (PHIJIN.GT.180.0.AND.PHIJIN.LE.270.0) GO TO 310
C                                                                     C
C  IF PHI JET IS IN     QUADRANT FOUR, ADJUST ITS INPUT VALUE         C
C                                                                     C
      PHIJIN=PHIJIN-360.
      JUMPMP = 4
      GO TO 340
C                                                                     C
C  IF PHI JET IS IN QUADRANT THREE, ADJUST INPUT VALUES PHIJET PHIM   C
C                                                                     C
  310 IF(PHIMIN.LT.180.)PHIMIN=180.-PHIMIN
      IF(PHIMIN.GT.180.)PHIMIN=540.-PHIMIN
      PHIJIN=180.-PHIJIN
      JUMPMP=3
      GO TO 340
C                                                                     C
C  IF PHI JET IS IN QUADRANT TWO, ADJUST INPUT VALUES PHIJET, PHIM    C
C                                                                     C
  320 IF(PHIMIN.LT.180.)PHIMIN=PHIMIN+180.
      IF(PHIMIN.GE.180.)PHIMIN=PHIMIN-180.
      PHIJIN=PHIJIN-180.
      JUMPMP=2
      GO TO 340
C                                                                     C
C  IF PHI JET IS IN QUADRANT ONE, ADJUST INPUT VALUES PHIJET, PHIM    C
C                                                                     C
  330 PHIMIN=360.-PHIMIN
      PHIJIN=-PHIJIN
      JUMPMP=1
C                                                                     C
C  INTERPOLATE ADJUSTED PHI JET, PHI M AND ALPHA VALUES               C
C  NEEDED FOR EACH QUADRANT                                           C
C                                                                     C
  340 GO TO 200
C                                                                     C
C  INITIALIZE VARIABLES USED IN THE BODY-ALONE PORTION OF             C
C  CALCULATIONS FOR THE MONOPLANE CONFIGURATION                       C
C                                                                     C
  350 GO TO 100
  355 IF (JUMPMP-2) 360,370,380
C                                                                     C
C  CALCULATE FINAL VALUES FOR MONOPLANE CONFIGURATION                 C
C  BY ADJUSTED QUADRANT LOCATION OF PHIJET                            C
C                                                                     C
C  QUADRANT ONE                                                       C
C                                                                     C
  360 CY=-CNT*SIN(PHIRAD)*CT
      CNJ=-CMJ1*SIN(PHIRAD)
      CL=-.6*CN*SIN(PHIRAD)
      GO TO 900
C                                                                     C
```

```
C  QUADRANT TWO                                                   C
C                                                                 C
 370 CMJ=-CMJ
     CN=-CN
     CY=-CNT*SIN(PHIRAD)*CT
     CNJ=-CMJ1*SIN(PHIRAD)
     CL=-0.6 *CN*SIN(PHIRAD)
     GO TO 900
C                                                                 C
C  QUADRANT THREE                                                 C
C                                                                 C
 380 IF (JUMPMP.EQ.4) GO TO 390
     CMJ=-CMJ
     CN=-CN
     CY=CNT*SIN(PHIRAD)*CT
     CNJ= CMJ1*SIN(PHIRAD)
     CL=.6*CN*SIN(PHIRAD)
     GO TO 900
C                                                                 C
C  QUADRANT FOUR
C                                                                 C
 390 CY=CNT*SIN(PHIRAD)*CT
     CNJ=CMJ1*SIN(PHIRAD)
     CL=(0.6)*CN*SIN(PHIRAD)
     GO TO 900
C                                                                 C
C  WRITE UNRECOVERABLE ERROR MESSAGE                              C
C                                                                 C
 400 WRITE(5,410)NCONFG
 410 FORMAT(1X,33HCONFIGURATION NUMBER IS INCORRECT, I5/)
 900 RETURN
     END
```

```
      SUBROUTINE TABULA (OPFLAG)
C                                                                       C
C     THIS SUBROUTINE IS CALLED FROM SUBROUTINE SIDJET TO INITIALIZE   C
C     DATA MATRICES USED IN INTERPOLATION OF NORMAL Y AND Z FORCES     C
C     AND MOMENTS                                                       C
C                                                                       C
      COMMON /MASTBL/ DCNX1(13,3,7),DCNX2(13,3,7),DCNX3(13,3,7),
     *                DCYX1(13,3,7),DCYX2(13,3,7),DCYX3(13,3,7),
     *                DCMX1(13,3,7),DCMX2(13,3,7),DCMX3(13,3,7),
     *                DCHX1(13,3,7),DCHX2(13,3,7),DCHX3(13,3,7),
     *                DCLX1(13,3,7),DCLX2(13,3,7),DCLX3(13,3,7)
      DIMENSION AN113(7),AY113(7),AM113(7),AH113(7),AL113(7),
     *          AN213(7),AY213(7),AM213(7),AH213(7),AL213(7),
     *          AN313(7),AY313(7),AM313(7),AH313(7),AL313(7),
     *          AN123(7),AY123(7),AM123(7),AH123(7),AL123(7),
     *          AN223(7),AY223(7),AM223(7),AH223(7),AL223(7),
     *          AN323(7),AY323(7),AM323(7),AH323(7),AL323(7),
     *          AN133(7),AY133(7),AM133(7),AH133(7),AL133(7),
     *          AN233(7),AY233(7),AM233(7),AH233(7),AL233(7),
     *          AN333(7),AY333(7),AM333(7),AH333(7),AL333(7),
     *          AN153(7),AY153(7),AM153(7),AH153(7),AL153(7),
     *          AN253(7),AY253(7),AM253(7),AH253(7),AL253(7),
     *          AN353(7),AY353(7),AM353(7),AH353(7),AL353(7),
     *          AN163(7),AY163(7),AM163(7),AH163(7),AL163(7),
     *          AN263(7),AY263(7),AM263(7),AH263(7),AL263(7),
     *          AN363(7),AY363(7),AM363(7),AH363(7),AL363(7)
      DIMENSION AN112(7),AY112(7),AM112(7),AH112(7),AL112(7),
     *          AN312(7),AY312(7),AM312(7),AH312(7),AL312(7),
     *          AN122(7),AY122(7),AM122(7),AH122(7),AL122(7),
     *          AN322(7),AY322(7),AM322(7),AH322(7),AL322(7),
     *          AN132(7),AY132(7),AM132(7),AH132(7),AL132(7),
     *          AN332(7),AY332(7),AM332(7),AH332(7),AL332(7),
     *          AN152(7),AY152(7),AM152(7),AH152(7),AL152(7),
     *          AN352(7),AY352(7),AM352(7),AH352(7),AL352(7),
     *          AN162(7),AY162(7),AM162(7),AH162(7),AL162(7),
     *          AN362(7),AY362(7),AM362(7),AH362(7),AL362(7)
      INTEGER OPFLAG
C                                                                       C
C     INSERT KNOWN PARAMETER VALUES FROM TABLES                         C
C                                                                       C
      DATA AN113/-.0826,.06,.10,.15,.2,.24,-.03/
      DATA AY113/.41,.38,.37,.36,.40,.41,.42/
      DATA AM113/-.5,-1.9,-1.9,-1.93,-2.2,-2.2,-1.4/
      DATA AH113/1.5,1.6,1.6,1.66,1.66,1.8,2.6/
      DATA AL113/.025,.136,.065,0.01,-.02,-.125,-.43/
      DATA AN213/.2,.17,.16,.15,.15,.12,.05/
      DATA AY213/.55,.54,.52,.52,.55,.59,.67/
      DATA AM213/-2.63,-2.63,-2.63,-2.63,-2.63,-2.63,-2.00/
      DATA AH213/3.0,2.8,2.6,2.57,2.3,2.3,2.6/
      DATA AL213/.41,.24,.12,0.08,0.04,-.09,-.38/
      DATA AN313/-.85,-.8,-.8,-.8,-.75,-.7,-.5/
      DATA AY313/1.16,1.16,1.16,1.16,1.16,1.16,1.16/
      DATA AM313/-1.8,-1.8,-1.8,-1.8,-1.8,-1.8,-1.8/
      DATA AH313/.24,.24,.24,.24,.24,.24,.24/
      DATA AL313/.00,.080,.02,.02,.05,.06,.28/
      DATA AN123/.13,.25,.15,.15,.2,.2,.02/
      DATA AY123/.26,.4,.44,.36,.36,.39,.47/
```

```
DATA AM123/-1.3,-2.3,-1.93,-1.93,-2.2,-2.2,-1.6/
DATA AH123/2.6,1.6,1.5,1.66,1.9,2.2,2.5/
DATA AL123/.2,.15,.09,0.01,-.08,-.16,-.41/
DATA AN223/.32,.25,.15,.15,.17,.13,0.0/
DATA AY223/.3,.45,.50,.52,.58,.62,.68/
DATA AM223/-3.0,-2.8,-2.7,-2.63,-2.7,-2.7,-2.5/
DATA AH223/3.0,2.6,2.3,2.57,2.3,2.2,2.5/
DATA AL223/.30,.25,.12,0.08,0.02,-.05,-.28/
DATA AN323/-.7,-.7,-.79,-.8,-.73,-.73,-.55/
DATA AY323/1.1,1.15,1.155,1.16,1.16,1.15,1.14/
DATA AM323/-2.0,-1.8,-1.8,-1.8,-1.8,-2.0,-2.0/
DATA AH323/.2,.15,.1,.24,.28,.32,.32/
DATA AL323/.07,.07,0.02,0.02,0.02,0.02,.24/
DATA AN133/.35,.33,.24,.15,.17,.12,-.07/
DATA AY133/0.0,.31,.39,.36,.33,.34,.48/
DATA AM133/-2.0,-2.2,-2.0,-1.93,-1.8,-1.6,-.9/
DATA AH133/2.9,1.8,1.3,1.66,2.0,2.2,2.8/
DATA AL133/.325,.125,.06,0.01,-.10,-.19,-.47/
DATA AN233/.42,.26,.20,.15,.15,.14,.13/
DATA AY233/.20,.40,.46,.52,.58,.65,.84/
DATA AM233/-3.2,-2.9,-2.7,-2.63,-2.8,-3.0,-2.8/
DATA AH233/3.2,2.6,2.57,2.57,2.4,2.2,2.0/
DATA AL233/.24,.17,.15,0.08,0.01,-.01,-.03/
DATA AN333/-.66,-.76,-.78,-.8,-.76,-.72,-.56/
DATA AY333/1.14,1.16,1.16,1.16,1.16,1.16,1.14/
DATA AM333/-1.8,-1.8,-1.8,-1.8,-1.8,-1.8,-1.8/
DATA AH333/.24,.24,.24,.24,.24,.24,.24/
DATA AL333/.07,.040,.020,0.02,0.0,0.0,.23/
DATA AN153/.4,.25,.2,.15,.03,-.08,-.44/
DATA AY153/0.0,.22,.29,.36,.26,.16,.43/
DATA AM153/-2.4,-2.5,-2.5,-1.93,-1.6,-1.0,-.5/
DATA AH153/3.1,2.2,1.66,1.66,2.2,2.4,2.1/
DATA AL153/.065,.026,.014,0.01,-.06,-.14,-.16/
DATA AN253/.22,.18,.16,.15,.05,0.0,-.06/
DATA AY253/.21,.40,.45,.52,.50,.60,.96/
DATA AM253/-2.9,-2.8,-2.7,-2.63,-2.6,-2.5,-2.4/
DATA AH253/2.8,2.6,2.57,2.57,2.6,2.2,1.6/
DATA AL253/-.15,0.04,0.08,0.08,.05,0.08,.3/
DATA AN353/-.8,-.8,-.8,-.8,-.8,-.8,-.8/
DATA AY353/1.12,1.14,1.15,1.16,1.06,1.08,1.13/
DATA AM353/-1.8,-1.8,-1.8,-1.8,-1.8,-1.8,-1.8/
DATA AH353/.24,.24,.24,.24,.24,.24,.24/
DATA AL353/0.0,0.0,0.02,0.02,0.0,0.02,.16/
DATA AN163/.47,.4,.28,.15,.06,-.06,-.38/
DATA AY163/0.0,.38,.4,.36,.29,.22,.28/
DATA AM163/-3.7,-3.2,-2.8,-1.93,-1.93,-1.6,-1.0/
DATA AH163/4.7,2.4,2.0,1.66,2.4,2.8,3.2/
DATA AL163/-.4,0.01,0.01,0.01,0.0,-.08,.09/
DATA AN263/.10,.18,.20,.15,.08,0.0,-.23/
DATA AY263/.52,.52,.52,.52,.48,.54,.72/
DATA AM263/-2.9,-3.0,-2.8,-2.63,-2.8,-2.7,-2.2/
DATA AH263/2.8,2.7,2.6,2.57,2.8,2.57,2.2/
DATA AL263/-.3,.02,.08,0.08,.085,.17,.39/
DATA AN363/-.6,-.7,-.7,-.8,-.8,-.8,-.95/
DATA AY363/1.17,1.19,1.17,1.16,1.12,1.08,1.05/
DATA AM363/-1.8,-1.8,-1.8,-1.8,-1.8,-1.8,-1.8/
DATA AH363/.24,.24,.24,.24,.24,.24,.24/
```

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      DATA AL363/.10,.10,.08,0.02,0.0,0.0,0.0/
      DATA AN112/.5,0.0,-.15,-.15,-.08,-.02,-.25/
      DATA AY112/-.1,.05,.10,.15,.17,.20,.29/
      DATA AM112/-4.0,-2.6,-2.0,-2.0,-2.4,-2.6,-2.5/
      DATA AH112/2.5,2.0,2.0,2.0,2.0,2.0,2.5/
      DATA AL112/.15,.04,.01,0.0,.06,.11,-.23/
      DATA AN312/-1.14,-1.14,-1.14,-1.14,-1.14,-1.14,-1.14/
      DATA AY312/1.14,1.14,1.14,1.14,1.14,1.14,1.14/
      DATA AM312/-1.0,-1.0,-1.0,-1.0,-1.0,-1.0,-1.0/
      DATA AH312/1.0,1.0,1.0,1.0,1.0,1.0,1.0/
      DATA AL312/.14,.055,.0275,0.0,-.02,-.03,-.08/
      DATA AN122/.5,.02,-.15,-.15,0.0,-.05,-.25/
      DATA AY122/-.2,.07,.15,.15,.15,.21,.38/
      DATA AM122/-3.6,-2.7,-2.0,-2.0,-2.2,-2.2,-2.0/
      DATA AH122/2.8,1.6,1.6,2.0,2.0,2.1,2.5/
      DATA AL122/-.01,.06,.03,0.0,.035,.07,-.22/
      DATA AN322/-1.14,-1.14,-1.14,-1.14,-1.14,-1.14,-1.14/
      DATA AY322/1.14,1.14,1.14,1.14,1.14,1.14,1.14/
      DATA AM322/-1.0,-1.0,-1.0,-1.0,-1.0,-1.0,-1.0/
      DATA AH322/1.0,1.0,1.0,1.0,1.0,1.0,1.0/
      DATA AL322/.04,.015,.08,0.0,0.0,0.0,0.0/
      DATA AN132/.32,-.02,-.13,-.15,-.08,-.14,-.3/
      DATA AY132/-.34,0.0,.12,.15,.06,.11,.26/
      DATA AM132/-3.0,-2.6,-2.0,-2.0,-2.0,-2.2,-2.2/
      DATA AH132/2.6,2.2,1.7,2.0,2.2,2.2,2.2/
      DATA AL132/0.0,0.0,0.0,0.0,-.01,-.02,-.06/
      DATA AN332/-1.14,-1.14,-1.14,-1.14,-1.14,-1.14,-1.14/
      DATA AY332/1.14,1.14,1.14,1.14,1.14,1.14,1.14/
      DATA AM332/-1.0,-1.0,-1.0,-1.0,-1.0,-1.0,-1.0/
      DATA AH332/1.0,1.0,1.0,1.0,1.0,1.0,1.0/
      DATA AL332/0.0,0.0,0.0,0.0,0.0,0.0,0.0/
      DATA AN152/0.0,-.10,-.12,-.15,-.18,-.21,-.3/
      DATA AY152/-.63,-.04,.15,.15,.04,-.02,.2/
      DATA AM152/-2.0,-2.0,-2.0,-2.0,-2.0,-2.0,-2.0/
      DATA AH152/4.0,2.7,2.0,2.0,2.0,2.4,2.2/
      DATA AL152/-.17,-.07,-.04,0.0,-.06,0.0,.17/
      DATA AN352/-1.14,-1.14,-1.14,-1.14,-1.14,-1.14,-1.14/
      DATA AY352/1.14,1.14,1.14,1.14,1.14,1.14,1.14/
      DATA AM352/-1.0,-1.0,-1.0,-1.0,-1.0,-1.0,-1.0/
      DATA AH352/1.0,1.0,1.0,1.0,1.0,1.0,1.0/
      DATA AL352/-.18,-.07,-.04,0.0,.015,.03,-.05/
      DATA AN162/.1,0.0,-.05,-.15,-.12,-.08,.04/
      DATA AY162/-.10,.10,.15,.15,.06,0.0,-.06/
      DATA AM162/-4.0,-3.0,-2.6,-2.0,-2.6,-2.6,-4.0/
      DATA AH162/4.4,2.7,2.2,2.0,2.6,3.0,4.0/
      DATA AL162/-.15,.08,.05,0.0,.05,.08,.2/
      DATA AN362/-1.14,-1.14,-1.14,-1.14,-1.14,-1.14,-1.14/
      DATA AY362/1.14,1.14,1.14,1.14,1.14,1.14,1.14/
      DATA AM362/-1.0,-1.0,-1.0,-1.0,-1.0,-1.0,-1.0/
      DATA AH362/1.0,1.0,1.0,1.0,1.0,1.0,1.0/
      DATA AL362/-.15,-.04,-.02,0.0,0.0,.02,.15/
C                                                                 C
C     EQUATE THESE TABLES WITH THEIR POSITION IN                  C
C     DATA MATRICES                                               C
C                                                                 C
      DO 1 L=1,7
                        DCNX1(1,3,L)=AN113(L)
```

```
      DCYX1(1,3,L)=AY113(L)
      DCMX1(1,3,L)=AM113(L)
      DCHX1(1,3,L)=AH113(L)
      DCLX1(1,3,L)=AL113(L)
      DCNX2(1,3,L)=AN213(L)
      DCYX2(1,3,L)=AY213(L)
      DCMX2(1,3,L)=AM213(L)
      DCHX2(1,3,L)=AH213(L)
      DCLX2(1,3,L)=AL213(L)
      DCNX3(1,3,L)=AN313(L)
      DCYX3(1,3,L)=AY313(L)
      DCMX3(1,3,L)=AM313(L)
      DCHX3(1,3,L)=AH313(L)
      DCLX3(1,3,L)=AL313(L)
    1 CONTINUE
C                                                                       C
C                                                                       C
      DO 2 L=1,7
      DCNX1(2,3,L)=AN123(L)
      DCYX1(2,3,L)=AY123(L)
      DCMX1(2,3,L)=AM123(L)
      DCHX1(2,3,L)=AH123(L)
      DCLX1(2,3,L)=AL123(L)
      DCNX2(2,3,L)=AN223(L)
      DCYX2(2,3,L)=AY223(L)
      DCMX2(2,3,L)=AM223(L)
      DCHX2(2,3,L)=AH223(L)
      DCLX2(2,3,L)=AL223(L)
      DCNX3(2,3,L)=AN323(L)
      DCYX3(2,3,L)=AY323(L)
      DCMX3(2,3,L)=AM323(L)
      DCHX3(2,3,L)=AH323(L)
      DCLX3(2,3,L)=AL323(L)
    2 CONTINUE
C                                                                       C
C                                                                       C
      DO 3 L=1,7
      DCNX1(3,3,L)=AN133(L)
      DCYX1(3,3,L)=AY133(L)
      DCMX1(3,3,L)=AM133(L)
      DCHX1(3,3,L)=AH133(L)
      DCLX1(3,3,L)=AL133(L)
      DCNX2(3,3,L)=AN233(L)
      DCYX2(3,3,L)=AY233(L)
      DCMX2(3,3,L)=AM233(L)
      DCHX2(3,3,L)=AH233(L)
      DCLX2(3,3,L)=AL233(L)
      DCNX3(3,3,L)=AN333(L)
      DCYX3(3,3,L)=AY333(L)
      DCMX3(3,3,L)=AM333(L)
      DCHX3(3,3,L)=AH333(L)
      DCLX3(3,3,L)=AL333(L)
    3 CONTINUE
C                                                                       C
```

```
C                                                                        C
      DO 4 L=1,7
                          DCNX1(5,3,L)=AN153(L)
                          DCYX1(5,3,L)=AY153(L)
                          DCMX1(5,3,L)=AM153(L)
                          DCHX1(5,3,L)=AH153(L)
                          DCLX1(5,3,L)=AL153(L)
                          DCNX2(5,3,L)=AN253(L)
                          DCYX2(5,3,L)=AY253(L)
                          DCMX2(5,3,L)=AM253(L)
                          DCHX2(5,3,L)=AH253(L)
                          DCLX2(5,3,L)=AL253(L)
                          DCNX3(5,3,L)=AN353(L)
                          DCYX3(5,3,L)=AY353(L)
                          DCMX3(5.3,L)=AM353(L)
                          DCHX3(5,3,L)=AH353(L)
                          DCLX3(5,3,L)=AL353(L)
    4 CONTINUE
C                                                                        C
C                                                                        C
      DO 5 L=1,7
                          DCNX1(6,3,L)=AN163(L)
                          DCYX1(6,3,L)=AY163(L)
                          DCMX1(6,3,L)=AM163(L)
                          DCHX1(6,3,L)=AH163(L)
                          DCLX1(6,3,L)=AL163(L)
                          DCNX2(6,3,L)=AN263(L)
                          DCYX2(6,3,L)=AY263(L)
                          DCMX2(6,3,L)=AM263(L)
                          DCHX2(6,3,L)=AH263(L)
                          DCLX2(6,3,L)=AL263(L)
                          DCNX3(6,3,L)=AN363(L)
                          DCYX3(6,3,L)=AY363(L)
                          DCMX3(6,3,L)=AM363(L)
                          DCHX3(6,3,L)=AH363(L)
                          DCLX3(6,3,L)=AL363(L)
    5 CONTINUE
C                                                                        C
C                                                                        C
      DO 6 L=1,7
                          DCNX1(1,2,L)=AN112(L)
                          DCYX1(1,2,L)=AY112(L)
                          DCMX1(1,2,L)=AM112(L)
                          DCHX1(1,2,L)=AH112(L)
                          DCLX1(1,2,L)=AL112(L)
                          DCNX3(1,2,L)=AN312(L)
                          DCYX3(1,2,L)=AY312(L)
                          DCMX3(1,2,L)=AM312(L)
                          DCHX3(1,2,L)=AH312(L)
                          DCLX3(1,2,L)=AL312(L)
    6 CONTINUE
C                                                                        C
```

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C                                                        C
      DO 7 L=1,7
                      DCNX1(2,2,L)=AN122(L)
                      DCYX1(2,2,L)=AY122(L)
                      DCMX1(2,2,L)=AM122(L)
                      DCHX1(2,2,L)=AH122(L)
                      DCLX1(2,2,L)=AL122(L)
                      DCNX3(2,2,L)=AN322(L)
                      DCYX3(2,2,L)=AY322(L)
                      DCMX3(2,2,L)=AM322(L)
                      DCHX3(2,2,L)=AH322(L)
                      DCLX3(2,2,L)=AL322(L)
    7 CONTINUE
C                                                        C
C                                                        C
      DO 8 L=1,7
                      DCNX1(3,2,L)=AN132(L)
                      DCYX1(3,2,L)=AY132(L)
                      DCMX1(3,2,L)=AM132(L)
                      DCHX1(3,2,L)=AH132(L)
                      DCLX1(3,2,L)=AL132(L)
                      DCNX3(3,2,L)=AN332(L)
                      DCYX3(3,2,L)=AY332(L)
                      DCMX3(3,2,L)=AM332(L)
                      DCHX3(3,2,L)=AH332(L)
                      DCLX3(3,2,L)=AL332(L)
    8 CONTINUE
C                                                        C
C                                                        C
      DO 9 L=1,7
                      DCNX1(5,2,L)=AN152(L)
                      DCYX1(5,2,L)=AY152(L)
                      DCMX1(5,2,L)=AM152(L)
                      DCHX1(5,2,L)=AH152(L)
                      DCLX1(5,2,L)=AL152(L)
                      DCNX3(5,2,L)=AN352(L)
                      DCYX3(5,2,L)=AY352(L)
                      DCMX3(5,2,L)=AM352(L)
                      DCHX3(5,2,L)=AH352(L)
                      DCLX3(5,2,L)=AL352(L)
    9 CONTINUE
C                                                        C
C                                                        C
      DO 10 L=1,7
                      DCNX1(6,2,L)=AN162(L)
                      DCYX1(6,2,L)=AY162(L)
                      DCMX1(6,2,L)=AM162(L)
                      DCHX1(6,2,L)=AH162(L)
                      DCLX1(6,2,L)=AL162(L)
                      DCNX3(6,2,L)=AN362(L)
                      DCYX3(6,2,L)=AY362(L)
                      DCMX3(6,2,L)=AM362(L)
                      DCHX3(6,2,L)=AH362(L)
                      DCLX3(6,2,L)=AL362(L)
   10 CONTINUE
C                                                        C
```

```
C     USE THE INITIAL TABLE ENTRIES TO CALCULATE REMAINING              C
C     VALUES TO FILL DATA MATRIX                                        C
C                                                                       C
      DO 12 J=1,3
      DO 11 L=1,7
                   DCNX2(J,2,L)=DCNX1(J,2,L)
                   DCYX2(J,2,L)=DCYX1(J,2,L)
                   DCMX2(J,2,L)=DCMX1(J,2,L)
                   DCHX2(J,2,L)=DCHX1(J,2,L)
                   DCLX2(J,2,L)=DCLX1(J,2,L)
   11 CONTINUE
   12 CONTINUE
      DO 14 J=5,6
      DO 13 L=1,7
                   DCNX2(J,2,L)=DCNX1(J,2,L)
                   DCYX2(J,2,L)=DCYX1(J,2,L)
                   DCMX2(J,2,L)=DCMX1(J,2,L)
                   DCHX2(J,2,L)=DCHX1(J,2,L)
                   DCLX2(J,2,L)=DCLX1(J,2,L)
   13 CONTINUE
   14 CONTINUE
      DO 15 L=1,7
                   DCNX1(5,1,L)=-DCYX1(1,3,L)
                   DCYX1(5,1,L)=-DCNX1(1,3,L)
                   DCMX1(5,1,L)=-DCHX1(1,3,L)
                   DCHX1(5,1,L)=-DCMX1(1,3,L)
                   DCLX1(5,1,L)=-DCLX1(1,3,L)
                   DCNX2(5,1,L)=-DCYX2(1,3,L)
                   DCYX2(5,1,L)=-DCNX2(1,3,L)
                   DCMX2(5,1,L)=-DCHX2(1,3,L)
                   DCHX2(5,1,L)=-DCMX2(1,3,L)
                   DCLX2(5,1,L)=-DCLX2(1,3,L)
                   DCNX3(5,1,L)=-DCYX3(1,3,L)
                   DCYX3(5,1,L)=-DCNX3(1,3,L)
                   DCMX3(5,1,L)=-DCHX3(1,3,L)
                   DCHX3(5,1,L)=-DCMX3(1,3,L)
                   DCLX3(5,1,L)=-DCLX3(1,3,L)
   15 CONTINUE
      DO 16 L=1,7
                   DCNX1(7,3,L)=DCNX1(1,3,8-L)
                   DCYX1(7,3,L)=DCYX1(1,3,8-L)
                   DCMX1(7,3,L)=DCMX1(1,3,8-L)
                   DCHX1(7,3,L)=DCHX1(1,3,8-L)
                   DCLX1(7,3,L)=DCLX1(1,3,8-L)
                   DCNX2(7,3,L)=DCNX2(1,3,8-L)
                   DCYX2(7,3,L)=DCYX2(1,3,8-L)
                   DCMX2(7,3,L)=DCMX2(1,3,8-L)
                   DCHX2(7,3,L)=DCHX2(1,3,8-L)
                   DCLX2(7,3,L)=DCLX2(1,3,8-L)
                   DCNX3(7,3,L)=DCNX3(1,3,8-L)
                   DCYX3(7,3,L)=DCYX3(1,3,8-L)
                   DCMX3(7,3,L)=DCMX3(1,3,8-L)
                   DCHX3(7,3,L)=DCHX3(1,3,8-L)
                   DCLX3(7,3,L)=DCLX3(1,3,8-L)
```

```
 16 CONTINUE
    DO 17 L=1,7
       DCNX1(11,1,L)=-DCYX1(1,3,8-L)
       DCYX1(11,1,L)=-DCNX1(1,3,8-L)
       DCMX1(11,1,L)=-DCHX1(1,3,8-L)
       DCHX1(11,1,L)=-DCMX1(1,3,8-L)
       DCLX1(11,1,L)=-DCLX1(1,3,8-L)
       DCNX2(11,1,L)=-DCYX2(1,3,8-L)
       DCYX2(11,1,L)=-DCNX2(1,3,8-L)
       DCMX2(11,1,L)=-DCHX2(1,3,8-L)
       DCHX2(11,1,L)=-DCMX2(1,3,8-L)
       DCLX2(11,1,L)=-DCLX2(1,3,8-L)
       DCNX3(11,1,L)=-DCYX3(1,3,8-L)
       DCYX3(11,1,L)=-DCNX3(1,3,8-L)
       DCMX3(11,1,L)=-DCHX3(1,3,8-L)
       DCHX3(11,1,L)=-DCMX3(1,3,8-L)
       DCLX3(11,1,L)=-DCLX3(1,3,8-L)
 17 CONTINUE
    DO 18 L=1,7
       DCNX1(4,1,L)=-DCYX1(2,3,L)
       DCYX1(4,1,L)=-DCNX1(2,3,L)
       DCMX1(4,1,L)=-DCHX1(2,3,L)
       DCHX1(4,1,L)=-DCMX1(2,3,L)
       DCLX1(4,1,L)=-DCLX1(2,3,L)
       DCNX2(4,1,L)=-DCYX2(2,3,L)
       DCYX2(4,1,L)=-DCNX2(2,3,L)
       DCMX2(4,1,L)=-DCHX2(2,3,L)
       DCHX2(4,1,L)=-DCMX2(2,3,L)
       DCLX2(4,1,L)=-DCLX2(2,3,L)
       DCNX3(4,1,L)=-DCYX3(2,3,L)
       DCYX3(4,1,L)=-DCNX3(2,3,L)
       DCMX3(4,1,L)=-DCHX3(2,3,L)
       DCHX3(4,1,L)=-DCMX3(2,3,L)
       DCLX3(4,1,L)=-DCLX3(2,3,L)
 18 CONTINUE
    DO 19 L=1,7
       DCNX1(8,3,L)=DCNX1(2,3,8-L)
       DCYX1(8,3,L)=DCYX1(2,3,8-L)
       DCMX1(8,3,L)=DCMX1(2,3,8-L)
       DCHX1(8,3,L)=DCHX1(2,3,8-L)
       DCLX1(8,3,L)=DCLX1(2,3,8-L)
       DCNX2(8,3,L)=DCNX2(2,3,8-L)
       DCYX2(8,3,L)=DCYX2(2,3,8-L)
       DCMX2(8,3,L)=DCMX2(2,3,8-L)
       DCHX2(8,3,L)=DCHX2(2,3,8-L)
       DCLX2(8,3,L)=DCLX2(2,3,8-L)
       DCNX3(8,3,L)=DCNX3(2,3,8-L)
       DCYX3(8,3,L)=DCYX3(2,3,8-L)
       DCMX3(8,3,L)=DCMX3(2,3,8-L)
       DCHX3(8,3,L)=DCHX3(2,3,8-L)
       DCLX3(8,3,L)=DCLX3(2,3,8-L)
 19 CONTINUE
    DO 20 L=1,7
       DCNX1(10,1,L)=-DCYX1(2,3,8-L)
       DCYX1(10,1,L)=-DCNX1(2,3,8-L)
       DCMX1(10,1,L)=-DCHX1(2,3,8-L)
       DCHX1(10,1,L)=-DCMX1(2,3,8-L)
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                  DCLX1(10,1,L)=-DCLX1(2,3,8-L)
                  DCNX2(10,1,L)=-DCYX2(2,3,8-L)
                  DCYX2(10,1,L)=-DCNX2(2,3,8-L)
                  DCMX2(10,1,L)=-DCHX2(2,3,8-L)
                  DCHX2(10,1,L)=-DCMX2(2,3,8-L)
                  DCLX2(10,1,L)=-DCLX2(2,3,8-L)
                  DCNX3(10,1,L)=-DCYX3(2,3,8-L)
                  DCYX3(10,1,L)=-DCNX3(2,3,8-L)
                  DCMX3(10,1,L)=-DCHX3(2,3,8-L)
                  DCHX3(10,1,L)=-DCMX3(2,3,8-L)
                  DCLX3(10,1,L)=-DCLX3(2,3,8-L)
 20 CONTINUE
    DO 21 L=1,7
                  DCNX1(3,1,L)=-DCYX1(3,3,L)
                  DCYX1(3,1,L)=-DCNX1(3,3,L)
                  DCMX1(3,1,L)=-DCHX1(3,3,L)
                  DCHX1(3,1,L)=-DCMX1(3,3,L)
                  DCLX1(3,1,L)=-DCLX1(3,3,L)
                  DCNX2(3,1,L)=-DCYX2(3,3,L)
                  DCYX2(3,1,L)=-DCNX2(3,3,L)
                  DCMX2(3,1,L)=-DCHX2(3,3,L)
                  DCHX2(3,1,L)=-DCMX2(3,3,L)
                  DCLX2(3,1,L)=-DCLX2(3,3,L)
                  DCNX3(3,1,L)=-DCYX3(3,3,L)
                  DCYX3(3,1,L)=-DCNX3(3,3,L)
                  DCMX3(3,1,L)=-DCHX3(3,3,L)
                  DCHX3(3,1,L)=-DCMX3(3,3,L)
                  DCLX3(3,1,L)=-DCLX3(3,3,L)
 21 CONTINUE
    DO 22 L=1,7
                  DCNX1(9,3,L)=DCNX1(3,3,8-L)
                  DCYX1(9,3,L)=DCYX1(3,3,8-L)
                  DCMX1(9,3,L)=DCMX1(3,3,8-L)
                  DCHX1(9,3,L)=DCHX1(3,3,8-L)
                  DCLX1(9,3,L)=DCLX1(3,3,8-L)
                  DCNX2(9,3,L)=DCNX2(3,3,8-L)
                  DCYX2(9,3,L)=DCYX2(3,3,8-L)
                  DCMX2(9,3,L)=DCMX2(3,3,8-L)
                  DCHX2(9,3,L)=DCHX2(3,3,8-L)
                  DCLX2(9,3,L)=DCLX2(3,3,8-L)
                  DCNX3(9,3,L)=DCNX3(3,3,8-L)
                  DCYX3(9,3,L)=DCYX3(3,3,8-L)
                  DCMX3(9,3,L)=DCMX3(3,3,8-L)
                  DCHX3(9,3,L)=DCHX3(3,3,8-L)
                  DCLX3(9,3,L)=DCLX3(3,3,8-L)
 22 CONTINUE
    DO 23 L=1,7
                  DCNX1(9,1,L)=-DCYX1(3,3,8-L)
                  DCYX1(9,1,L)=-DCNX1(3,3,8-L)
                  DCMX1(9,1,L)=-DCHX1(3,3,8-L)
                  DCHX1(9,1,L)=-DCMX1(3,3,8-L)
                  DCLX1(9,1,L)=-DCLX1(3,3,8-L)
                  DCNX2(9,1,L)=-DCYX2(3,3,8-L)
                  DCYX2(9,1,L)=-DCNX2(3,3,8-L)
                  DCMX2(9,1,L)=-DCHX2(3,3,8-L)
                  DCHX2(9,1,L)=-DCMX2(3,3,8-L)
                  DCLX2(9,1,L)=-DCLX2(3,3,8-L)
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                DCNX3(9,1,L)=-DCYX3(3,3,8-L)
                DCYX3(9,1,L)=-DCNX3(3,3,8-L)
                DCMX3(9,1,L)=-DCHX3(3,3,8-L)
                DCHX3(9,1,L)=-DCMX3(3,3,8-L)
                DCLX3(9,1,L)=-DCLX3(3,3,8-L)
   23 CONTINUE
      DO 24 L=1,7
                DCNX1(7,1,L)=-DCYX1(5,3,8-L)
                DCYX1(7,1,L)=-DCNX1(5,3,8-L)
                DCMX1(7,1,L)=-DCHX1(5,3,8-L)
                DCHX1(7,1,L)=-DCMX1(5,3,8-L)
                DCLX1(7,1,L)=-DCLX1(5,3,8-L)
                DCNX2(7,1,L)=-DCYX2(5,3,8-L)
                DCYX2(7,1,L)=-DCNX2(5,3,8-L)
                DCMX2(7,1,L)=-DCHX2(5,3,8-L)
                DCHX2(7,1,L)=-DCMX2(5,3,8-L)
                DCLX2(7,1,L)=-DCLX2(5,3,8-L)
                DCNX3(7,1,L)=-DCYX3(5,3,8-L)
                DCYX3(7,1,L)=-DCNX3(5,3,8-L)
                DCMX3(7,1,L)=-DCHX3(5,3,8-L)
                DCHX3(7,1,L)=-DCMX3(5,3,8-L)
                DCLX3(7,1,L)=-DCLX3(5,3,8-L)
   24 CONTINUE
      DO 25 L=1,7
                DCNX1(11,3,L)=DCNX1(5,3,8-L)
                DCYX1(11,3,L)=DCYX1(5,3,8-L)
                DCMX1(11,3,L)=DCMX1(5,3,8-L)
                DCHX1(11,3,L)=DCHX1(5,3,8-L)
                DCLX1(11,3,L)=DCLX1(5,3,8-L)
                DCNX2(11,3,L)=DCNX2(5,3,8-L)
                DCYX2(11,3,L)=DCYX2(5,3,8-L)
                DCMX2(11,3,L)=DCMX2(5,3,8-L)
                DCHX2(11,3,L)=DCHX2(5,3,8-L)
                DCLX2(11,3,L)=DCLX2(5,3,8-L)
                DCNX3(11,3,L)=DCNX3(5,3,8-L)
                DCYX3(11,3,L)=DCYX3(5,3,8-L)
                DCMX3(11,3,L)=DCMX3(5,3,8-L)
                DCHX3(11,3,L)=DCHX3(5,3,8-L)
                DCLX3(11,3,L)=DCLX3(5,3,8-L)
   25 CONTINUE
      DO 28 L=1,7
                DCNX1(1,1,L)=-DCYX1(5,3,L)
                DCYX1(1,1,L)=-DCNX1(5,3,L)
                DCMX1(1,1,L)=-DCHX1(5,3,L)
                DCHX1(1,1,L)=-DCMX1(5,3,L)
                DCLX1(1,1,L)=-DCLX1(5,3,L)
                DCNX2(1,1,L)=-DCYX2(5,3,L)
                DCYX2(1,1,L)=-DCNX2(5,3,L)
                DCMX2(1,1,L)=-DCHX2(5,3,L)
                DCHX2(1,1,L)=-DCMX2(5,3,L)
                DCLX2(1,1,L)=-DCLX2(5,3,L)
                DCNX3(1,1,L)=-DCYX3(5,3,L)
                DCYX3(1,1,L)=-DCNX3(5,3,L)
                DCMX3(1,1,L)=-DCHX3(5,3,L)
                DCHX3(1,1,L)=-DCMX3(5,3,L)
                DCLX3(1,1,L)=-DCLX3(5,3,L)
```

```
28 CONTINUE
   DO 27 K=1,3
   DO 26 L=1,7
                  DCNX1(13,K,L)=DCNX1(1,K,L)
                  DCYX1(13,K,L)=DCYX1(1,K,L)
                  DCMX1(13,K,L)=DCMX1(1,K,L)
                  DCHX1(13,K,L)=DCHX1(1,K,L)
                  DCLX1(13,K,L)=DCLX1(1,K,L)
                  DCNX2(13,K,L)=DCNX2(1,K,L)
                  DCYX2(13,K,L)=DCYX2(1,K,L)
                  DCMX2(13,K,L)=DCMX2(1,K,L)
                  DCHX2(13,K,L)=DCHX2(1,K,L)
                  DCLX2(13,K,L)=DCLX2(1,K,L)
                  DCNX3(13,K,L)=DCNX3(1,K,L)
                  DCYX3(13,K,L)=DCYX3(1,K,L)
                  DCMX3(13,K,L)=DCMX3(1,K,L)
                  DCHX3(13,K,L)=DCHX3(1,K,L)
                  DCLX3(13,K,L)=DCLX3(1,K,L)
26 CONTINUE
27 CONTINUE
   DO 29 L=1,7
                  DCNX1(6,1,L)=-DCYX1(6,3,8-L)
                  DCYX1(6,1,L)=-DCNX1(6,3,8-L)
                  DCMX1(6,1,L)=-DCHX1(6,3,8-L)
                  DCHX1(6,1,L)=-DCMX1(6,3,8-L)
                  DCLX1(6,1,L)=-DCLX1(6,3,8-L)
                  DCNX2(6,1,L)=-DCYX2(6,3,8-L)
                  DCYX2(6,1,L)=-DCNX2(6,3,8-L)
                  DCMX2(6,1,L)=-DCHX2(6,3,8-L)
                   DCHX2(6,1,L)=-DCMX2(6,3,8-L)
                  DCLX2(6,1,L)=-DCLX2(6,3,8-L)
                  DCNX3(6,1,L)=-DCYX3(6,3,8-L)
                  DCYX3(6,1,L)=-DCNX3(6,3,8-L)
                  DCMX3(6,1,L)=-DCHX3(6,3,8-L)
                  DCHX3(6,1,L)=-DCMX3(6,3,8-L)
                  DCLX3(6,1,L)=-DCLX3(6,3,8-L)
29 CONTINUE
   DO 30 L=1,7
                  DCNX1(12,3,L)=DCNX1(6,3,8-L)
                  DCYX1(12,3,L)=DCYX1(6,3,8-L)
                  DCMX1(12,3,L)=DCMX1(6,3,8-L)
                  DCHX1(12,3,L)=DCHX1(6,3,8-L)
                  DCLX1(12,3,L)=DCLX1(6,3,8-L)
                  DCNX2(12,3,L)=DCNX2(6,3,8-L)
                  DCYX2(12,3,L)=DCYX2(6,3,8-L)
                  DCMX2(12,3,L)=DCMX2(6,3,8-L)
                  DCHX2(12,3,L)=DCHX2(6,3,8-L)
                  DCLX2(12,3,L)=DCLX2(6,3,8-L)
                  DCNX3(12,3,L)=DCNX3(6,3,8-L)
                  DCYX3(12,3,L)=DCYX3(6,3,8-L)
                  DCMX3(12,3,L)=DCMX3(6,3,8-L)
                  DCHX3(12,3,L)=DCHX3(6,3,8-L)
                  DCLX3(12,3,L)=DCLX3(6,3,8-L)
```

```
30 CONTINUE
   DO 31 L=1,7
                 DCNX1(12,1,L)=-DCYX1(6,3,L)
                 DCYX1(12,1,L)=-DCNX1(6,3,L)
                 DCMX1(12,1,L)=-DCHX1(6,3,L)
                 DCHX1(12,1,L)=-DCMX1(6,3,L)
                 DCLX1(12,1,L)=-DCLX1(6,3,L)
                 DCNX2(12,1,L)=-DCYX2(6,3,L)
                 DCYX2(12,1,L)=-DCNX2(6,3,L)
                 DCMX2(12,1,L)=-DCHX2(6,3,L)
                 DCHX2(12,1,L)=-DCMX2(6,3,L)
                 DCLX2(12,1,L)=-DCLX2(6,3,L)
                 DCNX3(12,1,L)=-DCYX3(6,3,L)
                 DCYX3(12,1,L)=-DCNX3(6,3,L)
                 DCMX3(12,1,L)=-DCHX3(6,3,L)
                 DCHX3(12,1,L)=-DCMX3(6,3,L)
                 DCLX3(12,1,L)=-DCLX3(6,3,L)
31 CONTINUE
   DO 32 L=1,7
                 DCNX1(7,2,L)=DCNX1(1,2,8-L)
                 DCYX1(7,2,L)=DCYX1(1,2,8-L)
                 DCMX1(7,2,L)=DCMX1(1,2,8-L)
                 DCHX1(7,2,L)=DCHX1(1,2,8-L)
                 DCLX1(7,2,L)=DCLX1(1,2,8-L)
                 DCNX2(7,2,L)=DCNX2(1,2,8-L)
                 DCYX2(7,2,L)=DCYX2(1,2,8-L)
                 DCMX2(7,2,L)=DCMX2(1,2,8-L)
                 DCHX2(7,2,L)=DCHX2(1,2,8-L)
                 DCLX2(7,2,L)=DCLX2(1,2,8-L)
                 DCNX3(7,2,L)=DCNX3(1,2,8-L)
                 DCYX3(7,2,L)=DCYX3(1,2,8-L)
                 DCMX3(7,2,L)=DCMX3(1,2,8-L)
                 DCHX3(7,2,L)=DCHX3(1,2,8-L)
                 DCLX3(7,2,L)=DCLX3(1,2,8-L)
32 CONTINUE
   DO 33 L=1,7
                 DCNX1(11,2,L)=-DCYX1(1,2,8-L)
                 DCYX1(11,2,L)=-DCNX1(1,2,8-L)
                 DCMX1(11,2,L)=-DCHX1(1,2,8-L)
                 DCHX1(11,2,L)=-DCMX1(1,2,8-L)
                 DCLX1(11,2,L)=-DCLX1(1,2,8-L)
                 DCNX2(11,2,L)=-DCYX2(1,2,8-L)
                 DCYX2(11,2,L)=-DCNX2(1,2,8-L)
                 DCMX2(11,2,L)=-DCHX2(1,2,8-L)
                 DCHX2(11,2,L)=-DCMX2(1,2,8-L)
                 DCLX2(11,2,L)=-DCLX2(1,2,8-L)
                 DCNX3(11,2,L)=-DCYX3(1,2,8-L)
                 DCYX3(11,2,L)=-DCNX3(1,2,8-L)
                 DCMX3(11,2,L)=-DCHX3(1,2,8-L)
                 DCHX3(11,2,L)=-DCMX3(1,2,8-L)
                 DCLX3(11,2,L)=-DCLX3(1,2,8-L)
33 CONTINUE
   DO 34 L=1,7
                 DCNX1(4,2,L)=-DCYX1(2,2,L)
                 DCYX1(4,2,L)=-DCNX1(2,2,L)
                 DCMX1(4,2,L)=-DCHX1(2,2,L)
                 DCHX1(4,2,L)=-DCMX1(2,2,L)
                 DCLX1(4,2,L)=-DCLX1(2,2,L)
```

```
                  DCNX2(4,2,L)=-DCYX2(2,2,L)
                  DCYX2(4,2,L)=-DCNX2(2,2,L)
                  DCMX2(4,2,L)=-DCHX2(2,2,L)
                  DCHX2(4,2,L)=-DCMX2(2,2,L)
                  DCLX2(4,2,L)=-DCLX2(2,2,L)
                  DCNX3(4,2,L)=-DCYX3(2,2,L)
                  DCYX3(4,2,L)=-DCNX3(2,2,L)
                  DCMX3(4,2,L)=-DCHX3(2,2,L)
                  DCHX3(4,2,L)=-DCMX3(2,2,L)
                  DCLX3(4,2,L)=-DCLX3(2,2,L)
34 CONTINUE
   DO 35 L=1,7
                  DCNX1(8,2,L)=DCNX1(2,2,8-L)
                  DCYX1(8,2,L)=DCYX1(2,2,8-L)
                  DCMX1(8,2,L)=DCMX1(2,2,8-L)
                  DCHX1(8,2,L)=DCHX1(2,2,8-L)
                  DCLX1(8,2,L)=DCLX1(2,2,8-L)
                  DCNX2(8,2,L)=DCNX2(2,2,8-L)
                  DCYX2(8,2,L)=DCYX2(2,2,8-L)
                  DCMX2(8,2,L)=DCMX2(2,2,8-L)
                  DCHX2(8,2,L)=DCHX2(2,2,8-L)
                  DCLX2(8,2,L)=DCLX2(2,2,8-L)
                  DCNX3(8,2,L)=DCNX3(2,2,8-L)
                  DCYX3(8,2,L)=DCYX3(2,2,8-L)
                  DCMX3(8,2,L)=DCMX3(2,2,8-L)
                  DCHX3(8,2,L)=DCHX3(2,2,8-L)
                  DCLX3(8,2,L)=DCLX3(2,2,8-L)
35 CONTINUE
   DO 36 L=1,7
                  DCNX1(10,2,L)=-DCYX1(2,2,8-L)
                  DCYX1(10,2,L)=-DCNX1(2,2,8-L)
                  DCMX1(10,2,L)=-DCHX1(2,2,8-L)
                  DCHX1(10,2,L)=-DCMX1(2,2,8-L)
                  DCLX1(10,2,L)=-DCLX1(2,2,8-L)
                  DCNX2(10,2,L)=-DCYX2(2,2,8-L)
                  DCYX2(10,2,L)=-DCNX2(2,2,8-L)
                  DCMX2(10,2,L)=-DCHX2(2,2,8-L)
                  DCHX2(10,2,L)=-DCMX2(2,2,8-L)
                  DCLX2(10,2,L)=-DCLX2(2,2,8-L)
                  DCNX3(10,2,L)=-DCYX3(2,2,8-L)
                  DCYX3(10,2,L)=-DCNX3(2,2,8-L)
                  DCMX3(10,2,L)=-DCHX3(2,2,8-L)
                  DCHX3(10,2,L)=-DCMX3(2,2,8-L)
                  DCLX3(10,2,L)=-DCLX3(2,2,8-L)
36 CONTINUE
   DO 37 L=1,7
                  DCNX1(9,2,L)=DCNX1(3,2,8-L)
                  DCYX1(9,2,L)=DCYX1(3,2,8-L)
                  DCMX1(9,2,L)=DCMX1(3,2,8-L)
                  DCHX1(9,2,L)=DCHX1(3,2,8-L)
                  DCLX1(9,2,L)=DCLX1(3,2,8-L)
                  DCNX2(9,2,L)=DCNX2(3,2,8-L)
                  DCYX2(9,2,L)=DCYX2(3,2,8-L)
                  DCMX2(9,2,L)=DCMX2(3,2,8-L)
                  DCHX2(9,2,L)=DCHX2(3,2,8-L)
                  DCLX2(9,2,L)=DCLX2(3,2,8-L)
                  DCNX3(9,2,L)=DCNX3(3,2,8-L)
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                    DCYX3(9,2,L)=DCYX3(3,2,8-L)
                    DCMX3(9,2,L)=DCMX3(3,2,8-L)
                    DCHX3(9,2,L)=DCHX3(3,2,8-L)
                    DCLX3(9,2,L)=DCLX3(3,2,8-L)
37 CONTINUE
   DO 38 L=1,7
                    DCNX1(12,2,L)=DCNX1(6,2,8-L)
                    DCYX1(12,2,L)=DCYX1(6,2,8-L)
                    DCMX1(12,2,L)=DCMX1(6,2,8-L)
                    DCHX1(12,2,L)=DCHX1(6,2,8-L)
                    DCLX1(12,2,L)=DCLX1(6,2,8-L)
                    DCNX2(12,2,L)=DCNX2(6,2,8-L)
                    DCYX2(12,2,L)=DCYX2(6,2,8-L)
                    DCMX2(12,2,L)=DCMX2(6,2,8-L)
                    DCHX2(12,2,L)=DCHX2(6,2,8-L)
                    DCLX2(12,2,L)=DCLX2(6,2,8-L)
                    DCNX3(12,2,L)=DCNX3(6,2,8-L)
                    DCYX3(12,2,L)=DCYX3(6,2,8-L)
                    DCMX3(12,2,L)=DCMX3(6,2,8-L)
                    DCHX3(12,2,L)=DCHX3(6,2,8-L)
                    DCLX3(12,2,L)=DCLX3(6,2,8-L)
38 CONTINUE
   DO 39 L=1,7
                    DCNX1(2,1,L)=0.5*(DCNX1(1,1,L)+DCNX1(3,1,L))
                    DCYX1(2,1,L)=0.5*(DCYX1(1,1,L)+DCYX1(3,1,L))
                    DCMX1(2,1,L)=0.5*(DCMX1(1,1,L)+DCMX1(3,1,L))
                    DCHX1(2,1,L)=0.5*(DCHX1(1,1,L)+DCHX1(3,1,L))
                    DCLX1(2,1,L)=0.5*(DCLX1(1,1,L)+DCLX1(3,1,L))
                    DCNX2(2,1,L)=0.5*(DCNX2(1,1,L)+DCNX2(3,1,L))
                    DCYX2(2,1,L)=0.5*(DCYX2(1,1,L)+DCYX2(3,1,L))
                    DCMX2(2,1,L)=0.5*(DCMX2(1,1,L)+DCMX2(3,1,L))
                    DCHX2(2,1,L)=0.5*(DCHX2(1,1,L)+DCHX2(3,1,L))
                    DCLX2(2,1,L)=0.5*(DCLX2(1,1,L)+DCLX2(3,1,L))
                    DCNX3(2,1,L)=0.5*(DCNX3(1,1,L)+DCNX3(3,1,L))
                    DCYX3(2,1,L)=0.5*(DCYX3(1,1,L)+DCYX3(3,1,L))
                    DCMX3(2,1,L)=0.5*(DCMX3(1,1,L)+DCMX3(3,1,L))
                    DCHX3(2,1,L)=0.5*(DCHX3(1,1,L)+DCHX3(3,1,L))
                    DCLX3(2,1,L)=0.5*(DCLX3(1,1,L)+DCLX3(3,1,L))
39 CONTINUE
   DO 40 L=1,7
                    DCNX1(4,3,L)=0.5*(DCNX1(3,3,L)+DCNX1(5,3,L))
                    DCYX1(4,3,L)=0.5*(DCYX1(3,3,L)+DCYX1(5,3,L))
                    DCMX1(4,3,L)=0.5*(DCMX1(3,3,L)+DCMX1(5,3,L))
                    DCHX1(4,3,L)=0.5*(DCHX1(3,3,L)+DCHX1(5,3,L))
                    DCLX1(4,3,L)=0.5*(DCLX1(3,3,L)+DCLX1(5,3,L))
                    DCNX2(4,3,L)=0.5*(DCNX2(3,3,L)+DCNX2(5,3,L))
                    DCYX2(4,3,L)=0.5*(DCYX2(3,3,L)+DCYX2(5,3,L))
                    DCMX2(4,3,L)=0.5*(DCMX2(3,3,L)+DCMX2(5,3,L))
                    DCHX2(4,3,L)=0.5*(DCHX2(3,3,L)+DCHX2(5,3,L))
                    DCLX2(4,3,L)=0.5*(DCLX2(3,3,L)+DCLX2(5,3,L))
                    DCNX3(4,3,L)=0.5*(DCNX3(3,3,L)+DCNX3(5,3,L))
                    DCYX3(4,3,L)=0.5*(DCYX3(3,3,L)+DCYX3(5,3,L))
                    DCMX3(4,3,L)=0.5*(DCMX3(3,3,L)+DCMX3(5,3,L))
                    DCHX3(4,3,L)=0.5*(DCHX3(3,3,L)+DCHX3(5,3,L))
                    DCLX3(4,3,L)=0.5*(DCLX3(3,3,L)+DCLX3(5,3,L))
```

```
40 CONTINUE
   DO 41 L=1,7
                    DCNX1(8,1,L)=0.5*(DCNX1(7,1,L)+DCNX1(9,1,L))
                    DCYX1(8,1,L)=0.5*(DCYX1(7,1,L)+DCYX1(9,1,L))
                    DCMX1(8,1,L)=0.5*(DCMX1(7,1,L)+DCMX1(9,1,L))
                    DCHX1(8,1,L)=0.5*(DCHX1(7,1,L)+DCHX1(9,1,L))
                    DCLX1(8,1,L)=0.5*(DCLX1(7,1,L)+DCLX1(9,1,L))
                    DCNX2(8,1,L)=0.5*(DCNX2(7,1,L)+DCNX2(9,1,L))
                    DCYX2(8,1,L)=0.5*(DCYX2(7,1,L)+DCYX2(9,1,L))
                    DCMX2(8,1,L)=0.5*(DCMX2(7,1,L)+DCMX2(9,1,L))
                    DCHX2(8,1,L)=0.5*(DCHX2(7,1,L)+DCHX2(9,1,L))
                    DCLX2(8,1,L)=0.5*(DCLX2(7,1,L)+DCLX2(9,1,L))
                    DCNX3(8,1,L)=0.5*(DCNX3(7,1,L)+DCNX3(9,1,L))
                    DCYX3(8,1,L)=0.5*(DCYX3(7,1,L)+DCYX3(9,1,L))
                    DCMX3(8,1,L)=0.5*(DCMX3(7,1,L)+DCMX3(9,1,L))
                    DCHX3(8,1,L)=0.5*(DCHX3(7,1,L)+DCHX3(9,1,L))
                    DCLX3(8,1,L)=0.5*(DCLX3(7,1,L)+DCLX3(9,1,L))
41 CONTINUE
   DO 42 L=1,7
                    DCNX1(10,3,L)=0.5*(DCNX1(9,3,L)+DCNX1(11,3,L))
                    DCMX1(10,3,L)=0.5*(DCMX1(9,3,L)+DCMX1(11,3,L))
                    DCYX1(10,3,L)=0.5*(DCYX1(9,3,L)+DCYX1(11,3,L))
                    DCHX1(10,3,L)=0.5*(DCHX1(9,3,L)+DCHX1(11,3,L))
                    DCLX1(10,3,L)=0.5*(DCLX1(9,3,L)+DCLX1(11,3,L))
                    DCNX2(10,3,L)=0.5*(DCNX2(9,3,L)+DCNX2(11,3,L))
                    DCYX2(10,3,L)=0.5*(DCYX2(9,3,L)+DCYX2(11,3,L))
                    DCMX2(10,3,L)=0.5*(DCMX2(9,3,L)+DCMX2(11,3,L))
                    DCHX2(10,3,L)=0.5*(DCHX2(9,3,L)+DCHX2(11,3,L))
                    DCLX2(10,3,L)=0.5*(DCLX2(9,3,L)+DCLX2(11,3,L))
                    DCNX3(10,3,L)=0.5*(DCNX3(9,3,L)+DCNX3(11,3,L))
                    DCYX3(10,3,L)=0.5*(DCYX3(9,3,L)+DCYX3(11,3,L))
                    DCMX3(10,3,L)=0.5*(DCMX3(9,3,L)+DCMX3(11,3,L))
                    DCHX3(10,3,L)=0.5*(DCHX3(9,3,L)+DCHX3(11,3,L))
                    DCLX3(10,3,L)=0.5*(DCLX3(9,3,L)+DCLX3(11,3,L))
42 CONTINUE
   OPFLAG=999
   RETURN
   END
```

```
      SUBROUTINE INT(PHIK,PHIJ,ALPHA,ADC1,ADC2,
     *                XLO,XHI,IBOUND,AXIN,AXOUT)
C                                                                    C
C  THIS SUBROUTINE SEARCHES A RANGE TABLE TO CHOOSE                  C
C  BRACKETING VALUES FOR INPUT VARIABLES, THEN INTERPOLATES          C
C  THESE VALUES LAST-TO-FIRST                                        C
C                                                                    C
C                                                                    C
C  FIND BRACKETING INDICES AND VALUES FOR PHIM PHIJET AND ALPHA      C
C                                                                    C
      DIMENSION RTJ(13),RTK(3),RTL(7),ADC1(13,3,7),ADC2(13,3,7)
C                                                                    C
C  SET UP RANGE TABLES FOR PHIJET, PHIM AND ALPHA                    C
C                                                                    C
      DATA RTJ/0.0,22.5,45.0,67.5,90.0,135.0,180.0,202.5,
     *         225.0,247.5,270.0,315.0,360.0/
C                                                                    C
      DATA RTK/-22.5,-45.0,-67.5/
C                                                                    C
      DATA RTL/-10.0,-4.0,-2.0,0.0,2.0,4.0,10.0/
C                                                                    C
C  LOCATE UPPER AND LOWER VALUES OF PHIM, AND THEIR CORRESPONDING    C
C  SUBSCRIPTS; SAVE THESE AS NEW VARIABLES                           C
C                                                                    C
      DO 1 J=1,12
      IF (PHIJ.GE.RTJ(J).AND.PHIJ.LE.RTJ(J+1)) GO TO 10
    1 CONTINUE
C                                                                    C
C  SAVE VALUES AND SUBSCRIPTS FOR INTERPOLATION ROUTINES             C
C                                                                    C
   10 JLO=J
      JHI=J+1
      VALJLO=RTJ(J)
      VALJHI=RTJ(J+1)
C                                                                    C
C  DO THE SAME FOR PHIJET AND ALPHA                                  C
C                                                                    C
   15 DO 2 K=1,2
      IF (PHIK.LE.RTK(K).AND.PHIK.GE.RTK(K+1)) GO TO 20
    2 CONTINUE
      GO TO 60
   20 KLO=K+1
      KHI=K
      VALKHI=RTK(K)
      VALKLO=RTK(K+1)
C                                                                    C
   25 DO 3 L=1,6
      IF (ALPHA.GE.RTL(L).AND.ALPHA.LE.RTL(L+1)) GO TO 30
    3 CONTINUE
      GO TO 70
   30 LLO=L
      LHI=L+1
      VALLLO=RTL(L)
      VALLHI=RTL(L+1)
      GO TO 100
C                                                                    C
```

```
C   IF EITHER PHIK OR ALPHA ARE OUT OF BOUNDS, SET THESE EQUAL TO THE C
C   MINIMUM OR MAXIMUM RANGE VALUES AND CONTINUE                      C
C                                                                     C
   60 IF (PHIK.GT.-22.5) GO TO 65
      PHIK=-67.5
      GO TO 15
   65 PHIK=-22.5
      GO TO 15
C                                                                     C
   70 IF (ALPHA.GT.10) GO TO 75
      ALPHA=-10.0
      GO TO 25
   75 ALPHA=10.0
      GO TO 25
C                                                                     C
C                                                                     C
C   DO ACTUAL INTERPOLATION GIVEN PREVIOUSLY CALCULATED               C
C   BRACKETING VALUES                                                 C
C                                                                     C
  100 CALL TRITER(JLO,JHI,KLO,KHI,LLO,LHI,
     *              ALPHA,PHIK,PHIJ,AOUT1,
     *              VALJHI,VALKHI,VALLHI,VALJLO,VALKLO,VALLLO,ADC1)
C                                                                     C
      IF (IBOUND.EQ.1) GO TO 900
C                                                                     C
      CALL TRITER(JLO,JHI,KLO,KHI,LLO,LHI,
     *              ALPHA,PHIK,PHIJ,AOUT2,
     *              VALJHI,VALKHI,VALLHI,VALJLO,VALKLO,VALLLO,ADC2)
C                                                                     C
C   DO MATRIX-TO-MATRIX FINAL INTERPOLATION                           C
C                                                                     C
      AXOUT=(((AXIN-XLO)*(AOUT2-AOUT1))/(XHI-XLO))+AOUT1
      GO TO 999
  900 AXOUT=AOUT1
  999 RETURN
      END
```

```
      SUBROUTINE TRITER(JLO,JHI,KLO,KHI,LLO,LHI,
     *             ALPHA,PHIK,PHIJ,AOUT,
     *             VALJHI,VALKHI,VALLHI,VALJLO,VALKLO,VALLLO,ADC)
C                                                                       C
      DIMENSION ADC(13,3,7),AL(13,3),AK(13)
C                                                                       C
C   INTERPOLATE IN ALPHA                                                C
C                                                                       C
      DO 5 J=JLO,JHI
      DO 4 K=KHI,KLO
      AL(J,K)=(((ALPHA-VALLLO)*(ADC(J,K,LHI)-ADC(J,K,LLO)))
     *        /(VALLHI-VALLLO))+ADC(J,K,LLO)
    4 CONTINUE
    5 CONTINUE
C                                                                       C
C    INTERPOLATE IN PHIJET                                              C
C                                                                       C
  200 DO 6 J=JLO,JHI
      AK(J)=(((PHIK-VALKLO)*(AL(J,KHI)-AL(J,KLO)))
     *      /(VALKHI-VALKLO))+AL(J,KLO)
    6 CONTINUE
C                                                                       C
C   INTERPOLATE IN PHIM LAST                                            C
C                                                                       C
  400 AOUT=(((PHIJ-VALJLO)*(AK(JHI)-AK(JLO)))
     *     /(VALJHI-VALJLO))+AK(JLO)
      RETURN
      END
```

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